LSTAT2170 - Time Series

Modeling a time series for the Monthly temperature in Recife (Brazil)

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1 Introduction

The aim of this project is to analyse the mean monthly temperature in (°) in the city of Recife (Brazil) from 1986 to 1995.

First, we will begin by an analysis of the data. We will first check for any trend, seasonalities or variability of the variance and apply ad-hoc method in order to be able to analyze the ACF and PACF plots of the data. These plots should give us a first intuition of a possible model to model our data. We will then use automatic model selection using different criterions like the AIC, BIC in order to confirm our intuition and help us to select one or two final models. We will then test our model(s) ...

Finally, we will ensure our model has good prediction power use it to predict the temperature for the city of Recife in 1996.

2 Basic analysis of the data

2.1 Analyse of trend and seasonalities

Looking at the plot of the time serie for the mean monthly air temperature in Recife below (**??**), we directly notice a seasonality in the data. This was obviously expected as the temperatures fluctuate between seasons. However, this is not clear if there is any trend (*there seems to be a decrease in the mean monthly temperature which is kind of unexpected considering the climate change taking place since the beginning of the industrial era*) nor an instability in the variance. In order to have a clearer view of these elements, we can decompose the time serie by performing a **classical decomposition**. This method assume that the seasonal component repeat from year to year which is kind of a reasonable assumption for air temperature data. Let $\{ X_t, t \in \mathbb{Z} \}$ be our time serie, assuming an additive decomposition we can write,

$$X_t = S_t + T_t + R_t \tag{1}$$

with S_t, T_t and R_t respectively the seasonal, the trend-cycle and the remainder components.

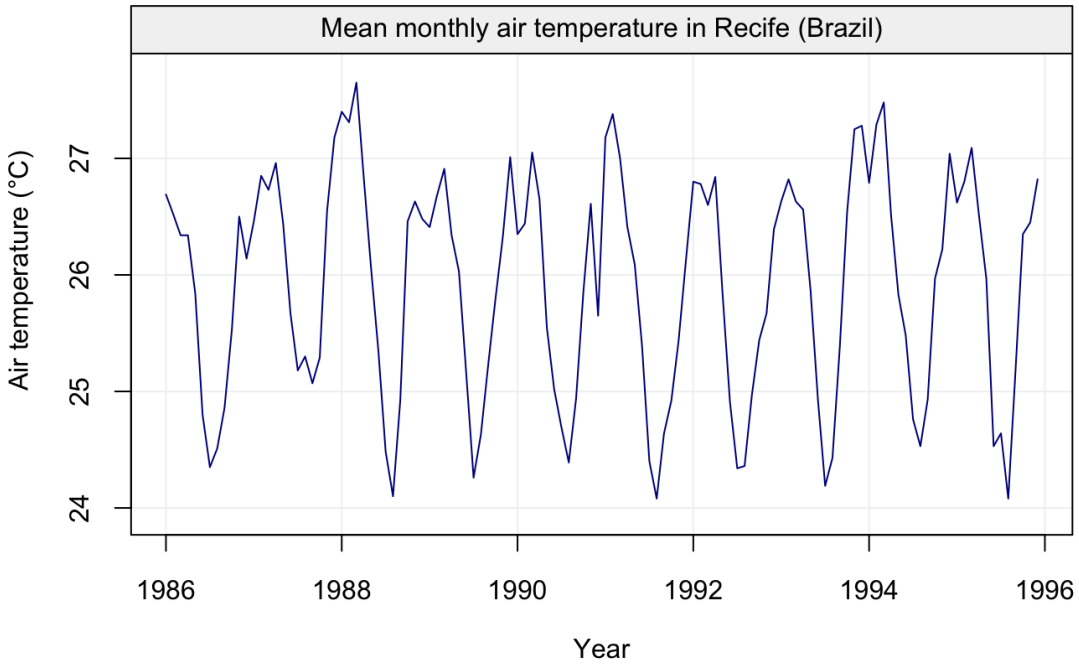

Figure 1 – *Time series for the mean monthly air temperature in the city of Recife (Brazil) for the years* 1986 – 1995

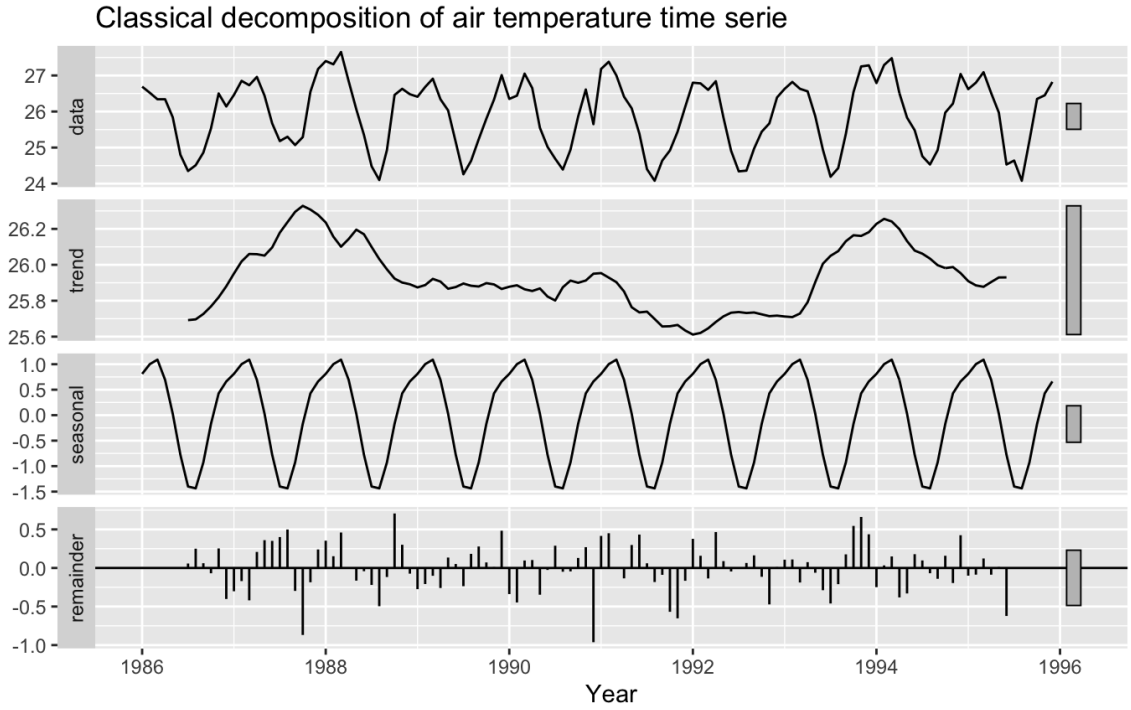

Figure 2 – *Decomposition of the time serie X_t into seasonal, trend-cycle and reminder components*

Being situated in the southern hemisphere, the Brazil has its seasons inverted compared to our regions. This country is situated near the equator and therefore has pretty high temperature all the year long. However, the highest temperatures happen between the end and the beginning of the year and the lowest toward the middle of the year. That's clearly what we can notice in the seasonal part (**??**). We can also notice a decreasing trend in the temperatures between 1988 and 1993 before it rises up again.

3 Box-Jenkins analysis

Before going further and select a model that will be able to predict the air temperature in Recife for the months following the year 1995, we need to detrend and deseasonalize our time serie.

3.1 Differencing

We first remove the seasonality by taking a seasonal difference which consist by taking the difference between an observation and the previous observation at the same season (in our case, 12 months before) : $X'_t = X_t - X_{t-12}$. Then, we remove the trend by first differencing the serie.

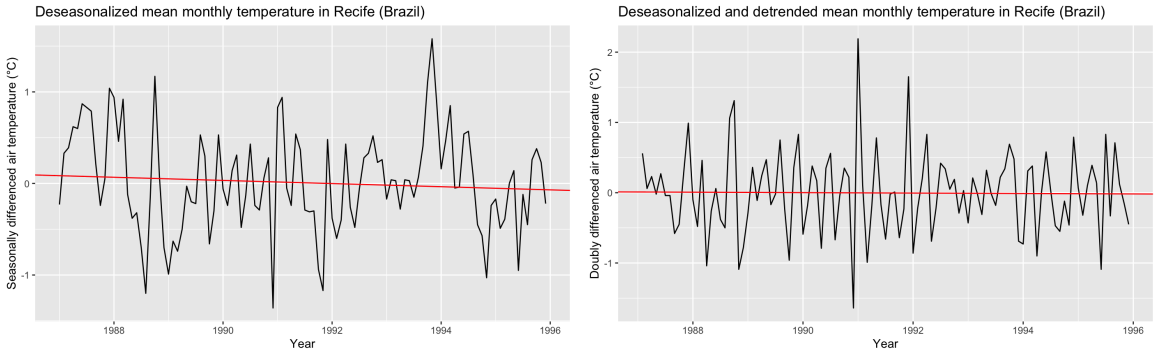

Figure 3 – *Deseasonalized time serie (at left) and doubly differenced time serie (deseasoned and detrended) (at right). In red is the regression line.*

After doubly differencing, the time serie is now stationary as shown on the plots above.

3.2 Model intuition with ACF and PACF plots

We can now look at the ACF and PACF plots.

3.3 Automatic model selection with AIC and BIC

Appendix